Measuring student performance in an international MSc programme

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Measuring student performance in an international MSc programme

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Abstract

The European Bologna Process initiated by the Bologna Declaration has increased the student mobility. The Technical University of Denmark (DTU) offers two years international Master of Science in Engineering programmes, and the present work addresses the question whether there is a difference in the student performance of international compared to Danish students in one of these programmes. The comparison is based on weighted grade average and course of study. The engineering education structure at DTU is explained and a number of results are discussed.

1. Introduction

The increased internationalisation in general and the Bologna Declaration in particular have increased the European engineering students' possibility of obtaining the bachelor degree at one university and the master degree at another. At the Technical University of Denmark (DTU) five years engineering education programmes were given in Danish until 2006, and students fulfilling the programme requirements obtained the degree Master of Science in Engineering (MSc). However as a consequence of the Bologna Declaration, the five years engineering programmes were split into two: three years Bachelor of Science in Engineering (BSc) programmes and two years MSc programmes. Also, as a consequence of the increased international mobility DTU changed its recruiting focus into attracting not only Danish but also international MSc students. Thus, since 2007 Danish and international students are following two years MSc programmes taught in English.

DTU has different type of general knowledge on student performance, [1]-[3], in the form of e.g.

- Grade profiles for each course module.
- Student evaluation of each course module.
- Average number of ECTS obtained per semester/year for exchange students with respect to home country.
- Student evaluation of start of study.

Also, for each MSc programme the university has knowledge, [4], on e.g.

- Number of students from Denmark and abroad.
- Number of students abandoning their study.
- Study length profiles.

However, what does not exist is a closer analysis of student choice of courses and student performance with respect to e.g. obtained grades in course modules and average number of ECTS within each MSc programme. This type of closer analysis is relevant for the further

development of the curriculum of the programme as well as the guiding and selection criteria used for enrolling students.

In the literature, the influence of the Bologna process on the engineering education curricula is discussed in e.g. [5]-[8]. In [5] some of the problems the authors see as a consequence of the Bologna process on the civil engineering education in Spain is addressed. A short survey of the implementation of the Bologna process in Electrical and Information Engineering (EIE) at the bachelor, master and PhD level is given in [6] as a description of the higher education system in EIE disciplines in two countries, Slovakia and Ireland. Papers [7] and [8] address mechanical engineering. Thus in [7] the process of changing traditional Portuguese mechanical engineering curricula into new programmes according to the framework of the Bologna protocol is presented and discussed, and in [8] the requirements of a curriculum in mechanical engineering education that will meet the needs of the market for newly graduated engineers are discussed. The effect of student mobility is addressed in e.g. [9] where the effect of studying abroad on international labour market mobility later in life for university graduates is investigated. However, studies on student performance within specific engineering programmes seem to be rather limited reported in the literature, if existing.

The focus of the present analysis is on whether there is a difference in the performance and choice of course modules of international compared to Danish students in one of DTU's MSc programmes, the MSc programme in Engineering Design and Applied Mechanics. The present work thus contributes in addressing the question whether educational background significantly influences the performance of MSc students.

The structure of the paper is as follows. In section 2, a description of the engineering education at DTU is given, including a description of the grading scale used in the assessment of students in course modules. In section 3, the method of analysis used in the present study is described. In section 4, the results are presented and discussed, and section 5 has a short conclusion.

2. Engineering education structure at DTU

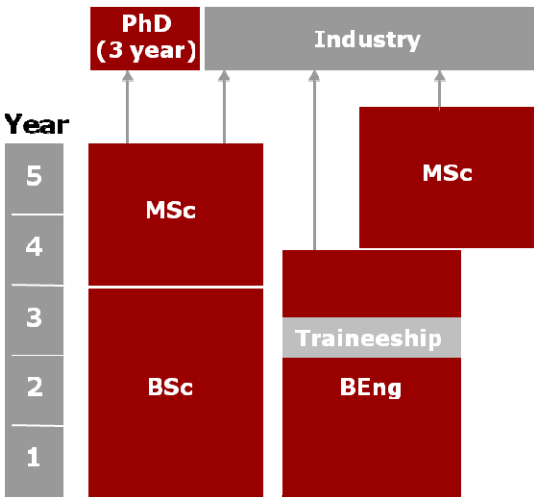

Figure 1. The engineering education structure at DTU.

DTU offers three separate teaching programmes in engineering, the three-year Bachelor of Science (BSc) programme, the 3.5-year Bachelor of Engineering (BEng) programme, and the two-year Master of Science (MSc) programme. The BSc and MSc programmes are results of the revision of the engineering education due to the Bologna process, while the BEng programmes have not been influenced by the process.

The BEng programmes include half a year traineeship in industry and are more reflecting engineering praxis and less theoretical than the BSc programmes. Most of the candidates with a BEng degree go directly to a job in industry, although they have the possibility to apply for a number of MSc programmes, while the majority of the BSc candidates continue for the MSc degree. The BSc and BEng programmes are both taught in Danish. The educational structure at DTU is schematically shown in Figure 1.

The MSc programmes at DTU have a workload of 120 ECTS equally divided between the four groups: General Competences (GC), Technology Specialization (TS), Electives, and Thesis project, see Figure 2.

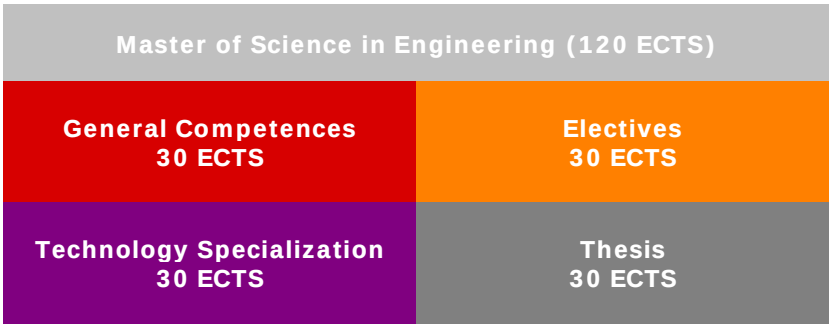

Figure 2. The structure of the MSc programmes at DTU.

For each MSc programme specific course modules are listed within the GC and TS groups, and the students are required to pass at least 60 ECTS of these listed course modules. The General Competence group is intended to offer students the range of skills necessary to meet the complex challenges of a modern engineering profession, including project management, teamwork, communication, problem-solving and resource planning. The Technology Specialization group and the MSc Thesis provide in-depth academic and technological training leading to a state-of-the-art qualification within the specific field of engineering. An important aspect of the MSc programmes is a significant number of Elective course modules. In principle the students can choose between more than 400 different DTU course modules. By combining GC and TS course modules with appropriate Elective course modules, students can create their own individual study programs reflecting their specific field of interest. The Elective group thus provides the student an opportunity to either focus even more on the chosen area of specialization or to supplement the academic specialization.

The MSc programme in Engineering Design and Applied Mechanics covers both the systematic engineering design methods within engineering design and product development, and analysis, numerical simulation, and optimization with focus on strength of structures, fluid flows, and energy conversion. A course of study within the programme may result in a broad-based education, but it is also possible to formulate a study plan with main focus in one of the five more narrowly defined disciplines: Engineering Design and Product Development, Strength and Dynamics of Structures, Industrial Fluid Mechanics, Energy Engineering, and Maritime Engineering.

The main part of the Danish MSc students has a BSc or a Bachelor in Engineering (BEng) degree from DTU and their educational background is thus well-known to DTU. The international MSc students come from all over the world, although the introduction of tuition fee has reduced the number of students from countries outside EU/EEA.

At DTU either a 7-point grading scale or passed/failed is applied to assess students in course modules. The grading scale uses the grades -3, 00, 02, 4, 7, 10, 12, where grade 02 is the lowest pass grade and 12 is the maximum obtainable grade.

3. Method of analysis

The present analysis is based on weighted average of each student's grades obtained in course modules passed during the MSc study. The course modules represented in the analysis are course modules within the General Competences (GC) and Technology Specialization (TS) groups. The GC group is for Engineering Design and Applied Mechanics, at the time of enrolment for the students analysed, divided into two groups: one group of 3 course modules corresponding to 25 ECTS of which min. 15 ECTS has to be taken, and another group of 10 course modules corresponding to 72.5 ECTS of which the student has to pass min. 15 ECTS. The TS group consists of 20 course modules corresponding to 147.5 ECTS of which the student has to pass 30 ECTS. The course modules in the two groups correspond to either 5, 7½, or 10 ECTS. In the present analysis only course modules using the 7-point grading scale in the assessment of students are included in the analysis and each grade is weighted by the course module's corresponding number of ECTS.

The population represents students who have started on the MSc programme in 2008 or spring 2009 and still are registered as students in June 2010. The data thus corresponds to at least 1½ year of studying with grades registered in the DTU system by June 2010. The students' entrance degree were either a BSc (21 students) or BEng (17 students) from DTU, or an international engineering bachelor degree (9 students). While all international MSc students begin their studies in the fall semester, Danish MSc students can begin their studies in the fall or spring semester.

4. Results and discussion

Figure 3 shows the performance of MSc students in Engineering Design and Applied Mechanics given in terms of a weighted grade average and the corresponding accumulated ECTS based on the students' grades and obtained ECTS for the specific course modules within the GC and TS groups. The lowest pass grade, grade 02, is marked by a red line in figure. The first indication given in the figure is an acceptable performance of the international students compared to the Danish students. The figure also indicate an influence of the educational background in the way that the students with a BSc from DTU in average seem to obtain higher weighted grade average than the BEng from DTU and the international students. At DTU all course modules within the GC and TS groups are advanced course modules requiring prerequisites within the academic field of the specific course module, and the advanced courses are usually in their prerequisites adjusted to basic course modules offered the BSc students. The MSc course modules thus typically match BSc course modules at DTU, but do not necessarily take into account the differences when it comes to an educational background as BEng or international bachelor. Furthermore, as MSc students at DTU are given large influence on their own course of study it is also required that each student take responsibility for his/here own study as well as own learning. While the BSc students at DTU are accustomed to the need of self-discipline and focus in study planning it may give the BEng and international students an extra challenge.

As the international students perform satisfactory compared to the Danish students a first conclusion is that the selection criteria used for enrolling international students seems to be working satisfactory.

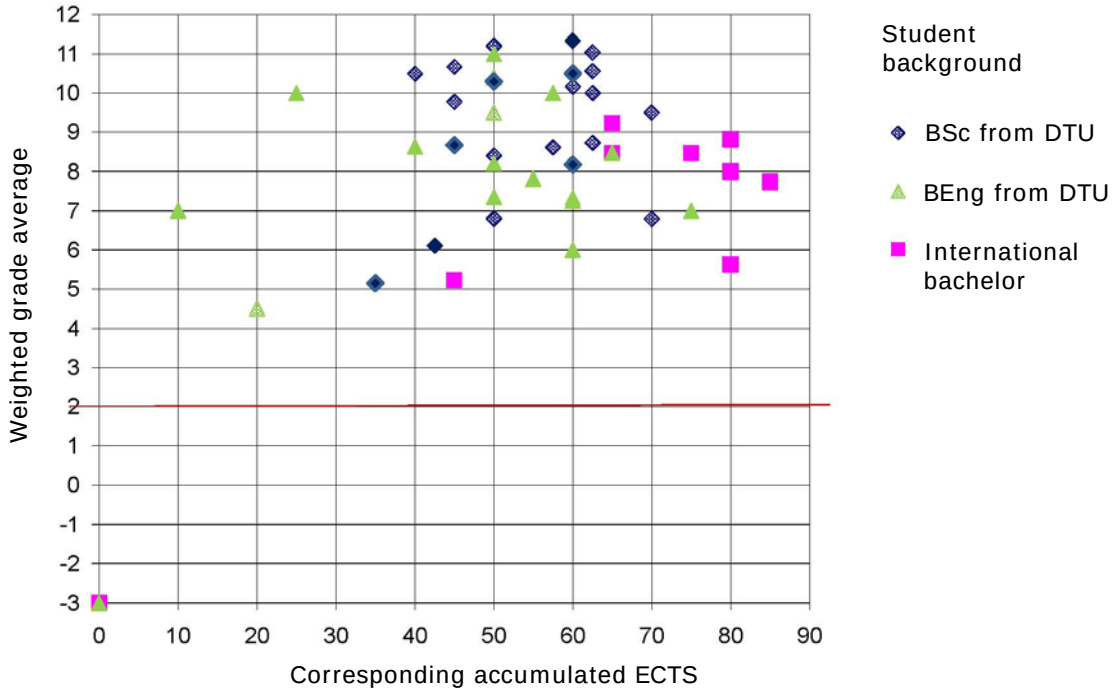

Figure 3. Weighted grade average vs corresponding accumulated ECTS within the GC and TS groups obtained during the MSc study.

For the MSc students in Engineering Design and Applied Mechanics, figure 4 shows the accumulated ECTS in the GC and TS groups' course modules relative to the student's total accumulated ECTS in all course modules (GC, TS and Elective groups) during the MSc study. The figure indicates a slight difference in choice of course modules. Thus, the international MSc student chooses in average more course modules among the GC and TS groups than the required 60 ECTS, indicated by the red line, while the Danish students choose in average less than 60 ECTS among the GC and TS groups during their MSc study. This indicates an interesting difference in perception between Danish and international students with respect to the GC and TS course modules. The Danish students act as they see the requirements as a straitjacket limiting the possibility to design their own individual study plan. The international students act as they see the GC and TS requirements as DTU guide lines (a piece of good advice) in selecting course modules.

The Danish BSc and BEng students as well as international guest students at DTU do have the option as part of their bachelor to participate in course modules within the GC and TS groups. When enrolled in the corresponding MSc programme, the students then have the option to transfer the ECTS credits obtained within the GC and TS groups during the bachelor education to the MSc study thereby increasing the number of ECTS in the Electives group correspondingly.

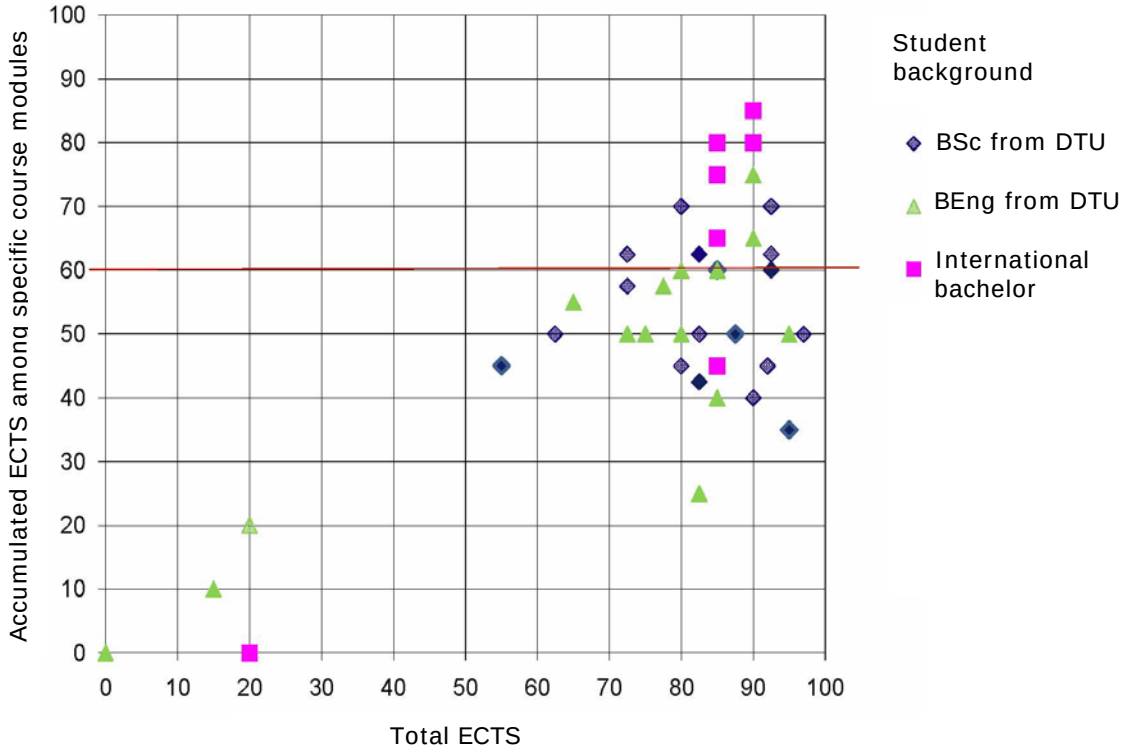

Figure 4. Accumulated ECTS within the GC and TS groups vs total accumulated ECTS, both obtained in course modules during the MSc study.

Figure 5 shows how many of the ECTS within the GC and TS groups the MSc students in Engineering Design and Applied Mechanics have obtained during the MSc and bachelor study, respectively. The percentages shown with respect to educational background in table 1 are calculated based on figure 5. Firstly, the percentage of students who have passed course modules within the GC and TS groups during their bachelor study is shown. Secondly, table 1 shows the percentage of students who have passed more than 60 ECTS within the GC and TS groups during their MSc study, and thirdly is shown the percentage of students who have passed more than 60 ECTS within the GC and TS groups during the MSc study and have obtained no ECTS credits within these groups during the bachelor study.

It is remarkable to observe, as also indicated in figure 4, that 77% of the international students while only 47% of the DTU BSc and 17% of the DTU BEng candidates pass more than the required 60 ECTS within the GC and TS groups during their MSc study. The majority of the students who have passed more than 60 ECTS within the GC and TS groups during their MSc study have not obtained ECTS credits within these groups as part of their bachelor education. Thus, 85% of international students have not obtained ECTS credits within the GC and TS groups during their bachelor education if they pass more than 60 ECTS within these groups during their MSc study. This is not surprising as the majority of the international MSc students have not been DTU guest students. However, it is notable that among the corresponding Danish students 70% and 66% have not started focusing on the course modules within the GC and TS groups as part of their BSc and BEng education, respectively.

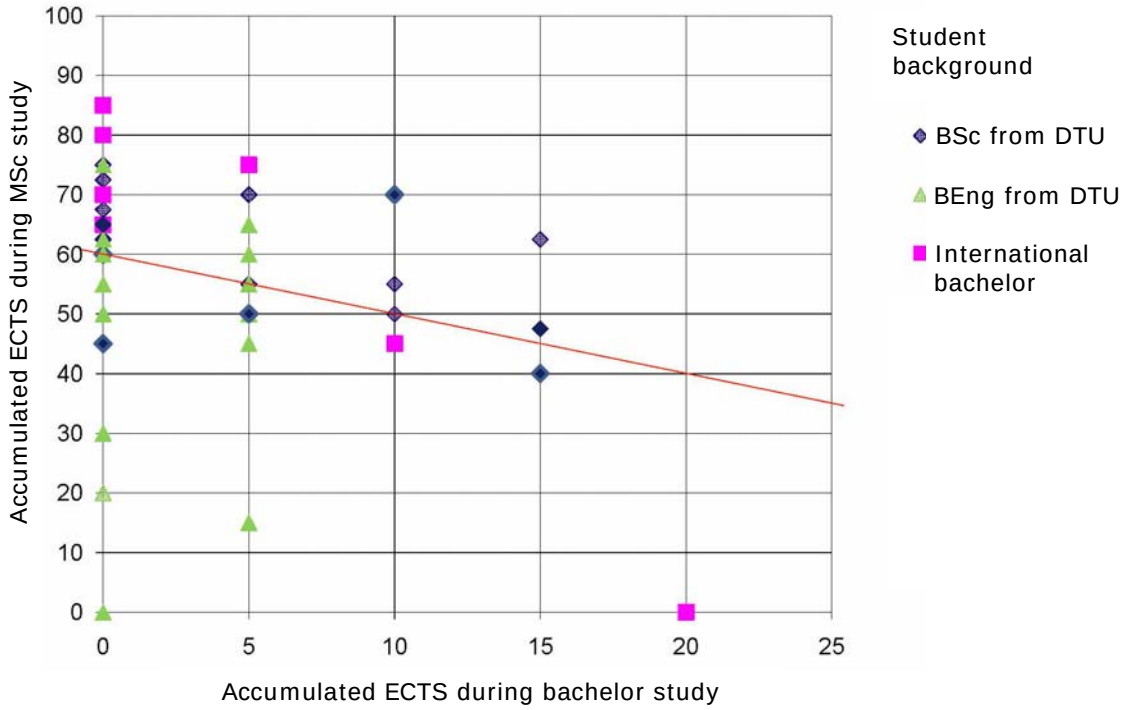

Figure 5. Accumulated ECTS within the GC and TS groups during the MSc study vs accumulated ECTS within the GC and TS groups during the bachelor study.

Table 1. Percentages of students who have passed course modules within the GC and TS groups 1) as part of their bachelor, 2) more than 60 ECTS within these groups as part of their MSc study, and 3) more than 60 ECTS within these groups as part of their MSc study but no course modules belonging to these groups as part of their bachelor study.

Course modules within the GC and TS groups	BSc from DTU	BEng from DTU	International bachelor
During bachelor study: > 0 ECTS	52%	41%	33%
During MSc study: > 60 ECTS	47%	17%	77%
During MSc study: > 60 ECTS. During bachelor study: = 0 ECTS	70% (of 47%)	66% (of 17%)	85% (of 77%)

The red line in figure 5 corresponds to the 60 ECTS to be obtained within the GC and TS groups in order to fulfil the requirement for the MSc programme. The slope of the line takes into account that part of the competences within these groups may be obtained during the bachelor education.

Figure 5 and table 1 indicate that the Danish students exploit the possibility to partly fulfil the competences within the GC and TS group during their bachelor study whereby they reduce the

workload within the GC and TS groups during the 2 years MSc study. Apart from reducing the workload this may also influence on the grades obtained, as many of the courses within the GC and TS groups are considered to be work intensive.

Figure 5 also indicates a number of students who are not very active in finishing their MSc. In the case of Danish students this tendency is largest among the BEng as some of these students goes to industry instead of finishing the MSc. The vast majority of the international students are clearly very active in fulfilling the requirement.

The difference in choice of course modules seen in figures 4 and 5 may be due to the international students being much focused academically why they to a larger extent choose course modules in accordance with what they consider as the DTU guide lines within the MSc programme. It may also reflect a difference in educational background. While the Danish students are very keen on keeping a large degree of freedom of choice in their education and thus more consider the rules and regulation for the MSc programmes as limiting their freedom of choice, the international students see the many possibilities within the programmes.

5. Conclusion

The results shown indicate an acceptable performance of the international students compared to the Danish students as well as an interesting difference in choice of course modules. The results also indicate that the selection criteria used for enrolling international students seems to be working satisfactory. The future work will be to follow the development in the coming years. Also, the identified difference in choice of course modules could be investigated by e.g. a more qualitative approach as interviewing the MSc students with respect to their chosen course of study.

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